On the synonymy between *Aplysia winneba* Eales, 1957 and *Aplysia fasciata* Poiret, 1789 (Mollusca: Opisthobranchia: Anaspidea)

Sobre la sinonimia entre *Aplysia winneba* Eales, 1957 y *Aplysia fasciata* Poiret, 1789 (Mollusca: Opisthobranchia: Anaspidea)

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ABSTRACT

The anatomy and geographical range of the opisthobranch mollusc *Aplysia fasciata* Poiret, 1789, a species widely distributed in East Atlantic and Mediterranean waters, are reviewed. A detailed anatomical description of this species is given, and radula, jaw elements and palatal teeth are illustrated using the scanning electron microscope (SEM).
Examination of the type material of *Aplysia winneba* Eales, 1957, originally described from Ghana, revealed that this species is a synonym of *Aplysia fasciata* Poiret, 1789. Literature references to *Aplysia brasiliana* Rang, 1828 in the eastern Atlantic are missidentifications of some specimens of *Aplysia fasciata*, deposited in the Natural History Museum of London.

RESUMEN

En este trabajo se revisan la anatomía y la distribución geográfica de *Aplysia fasciata* Poiret, 1789, una especie ampliamente distribuida en el Atlántico Este y en el Mediterráneo. Se da una detallada descripción anatómica de esta especie, y se describen la rádula, armadura labial y elementos palatales usando el microscopio electrónico de barrido.
El exámen del material tipo de *Aplysia winneba* Eales, 1957, descrita originalmente en las costas de Ghana, nos lleva a proponer la sinonimia entre esta especie y *Aplysia fasciata* Poiret, 1789. Por otra parte, las referencias en la literatura a la especie *Aplysia brasiliana* Rang, 1828, en aguas del Atlántico oriental son debidas a una incorrecta identificación de algunos ejemplares de *A. fasciata* depositados en las colecciones del Natural History Museum de Londres.

KEY WORDS: *Aplysia fasciata*, *Aplysia winneba*, opisthobranchs, Anaspidea, East Atlantic, taxonomy.
PALABRAS CLAVE: *Aplysia fasciata*, *Aplysia winneba*, opistobranquios, Anaspidea, Atlántico este, taxonomía.

INTRODUCTION

Members of the opisthobranch family Aplysiidae are characterised by having a globose body and two well developed and symmetrical parapodia that, in some cases, are joined posteriorly. A flat shell is always present, and

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the body surface is smooth, without any tubercles. A more complete description can be found in EALES (1960) and BEEMAN (1968). The family includes two genera, *Aplysia* Linnaeus, 1767 and *Syphonota* Adams, 1854, the latter being a circumtropical genus. *Syphonota* differs from *Aplysia* by the position of the rhinophores, close together and set back almost between the parapodial flaps, rather than in front of them (EALES, 1960).

Species of *Aplysia* has been usually differentiated on the basis of external characters, mainly the size and shape of the parapodial lobes, the size of the mantle foramen and the shape of the shell, as well as the penial morphology (EALES, 1960; THOMPSON, 1976). The morphology of the hard parts of the buccal mass, and mainly of the radular teeth, has been also used, but radular morphology has been not studied with detail in all species belonging to this genus.

The Aplysiidae of European and West African shores and of the Macaronesian Islands have been previously studied in several papers: RISBEC, 1931; ODHNER, 1932; GRIGG, 1949; PRUVOT-FOL, 1953; GANTÉS, 1956; EALES, 1957a, 1957b; BEBBINGTON AND THOMPSON, 1968; BEBBINGTON, 1970, 1975; BEBBINGTON AND BROWN, 1975; THOMPSON, 1976; EDMUNDS, 1978; BEBBINGTON, 1982; BALLESTEROS AND TEMPLADO, 1987; ORTEA AND MARTÍNEZ, 1991; MALAQUIAS AND CALADO, 1997; WIRTZ AND MARTINS, 1993, among others. In her world-wide revision of the genus *Aplysia* EALES (1960) recorded 35 species, nine of which inhabit East Atlantic waters: *Aplysia parvula*, *A. punctata*, *A. fasciata*, *A. dactylomela*, *A. brasiliana*, *A. winneba*, *A. depilans*, *A. juliana* and *A. dura*.

Despite this proliferation of papers, a review of some problematic species seemed to be necessary to have a more complete knowledge of the East Atlantic Aplysiidae. Among them, the validity of the species *Aplysia winneba*, originally described from Ghana shores and, subsequently, only recorded from Cape Verde (EALES, 1957a) and from Senegal (EDMUNDS, 1978; BEBBINGTON, 1982). The main objective of the present paper is to clarify the identity of *Aplysia winneba*, on the basis of a re-examination of the type material and additional specimens assigned to *Aplysia fasciata*. Another question is the reference to *Aplysia brasiliana* as an amphiatlantic opisthobranch, after two records made by EALES (1960) off Saint Helena and Ghana shores. East Atlantic specimens of *A. brasiliana* studied by Eales are also re-examined, in orden to clarify the possible alleged amphiatlantic character of this species.

MATERIAL AND METHODS

The specimens studied in this paper were collected by the authors, provided by some colleagues or borrowed from the following institutions: MNCN Museo Nacional de Ciencias Naturales, Madrid; MNHN Muséum National d' Histoire Naturelle, Paris; NHM Natural History Museum, London.

Several specimens were dissected and hard parts of the buccal bulb were studied by scanning electron microscopy (SEM).

SYSTEMATICS

Family Aplysiidae Lamarck, 1809
Genus *Aplysia* Linnaeus, 1767
Aplysia fasciata Poiret, 1789

Aplysia fasciata Poiret, 1789, *Voy. Barbarie*, 2: 2 [Type locality: shores of Barbarie (around El Kala, East of Algeria)].

Tethys leporina Linnaeus, 1758, *Syst. Nat.*, 10: 563 (non *Tethys leporina* Linnaeus, 1767, *Syst. Nat.*, 12: 1089 - Nudibranchia).
Aplysia alba Cuvier, 1803, *Ann. Mus. d' Hist. Nat.*, 2: 295, Pl. I, fig. 6.
Aplysia camelus Cuvier, 1803, *Ann. Mus. d' Hist. Nat.*, 2: 295, Pl. I, fig.1.
Aplysia napolitana delle Chiaje, 1823, *Mem. sulla storia e notomia degli anim. s. vert. del Reg. di Napoli*, 1: 31,39, 70, Pl. III, fig. 2.
Aplysia vulgaris de Blainville, 1823, *J. Phys. Chim. Hist. Nat. et des Arts*, 96: 285, figs. 1-2.
Aplysia marmorata de Blainville, 1823, *J. Phys. Chim. Hist. Nat. et des Arts*, 96: 286, figs. 3-4.
Dolabella lepus Risso, 1826, *Hist. Nat. de l' Europe mérid.*, 4: 44, Pl. I, figs. 1-2.
Aplysia radiata Crouch, 1826, *Illustr. Introd. Lam. Conch.*: 44, Pl. XIV, figs. 10, 10a.
Aplysia lepus (Risso): Philippi, 1844, *Enum. Moll. Sicil.*, 2: 99.
Aplysia cameliformis Locard, 1886, *Ann. Soc. Agric. Lyon*, 8: 66.
Aplysia winneba Eales, 1957, *Proc. Malac. Soc. London*, 32 (4): 180-183, figs. 1-6 (*sin. nov.*)
Aplysia gracilis Eales, 1960, *Bull. British Mus. (Nat. Hist.), Zoology*, 5: 320-321, fig. 26.

EALES (1960: 315) included *A. limacina* de Blainville, 1823, among the synonyms of *Aplysia fasciata*, although the specimen figured by de Blainville is clearly not an *Aplysia*, but rather a *Phyllaplysia*. There are several subsequent references to *A. fasciata* as *A. limacina* (GRIGG, 1949; IMPERATO, MINALE AND RICCIO, 1977).

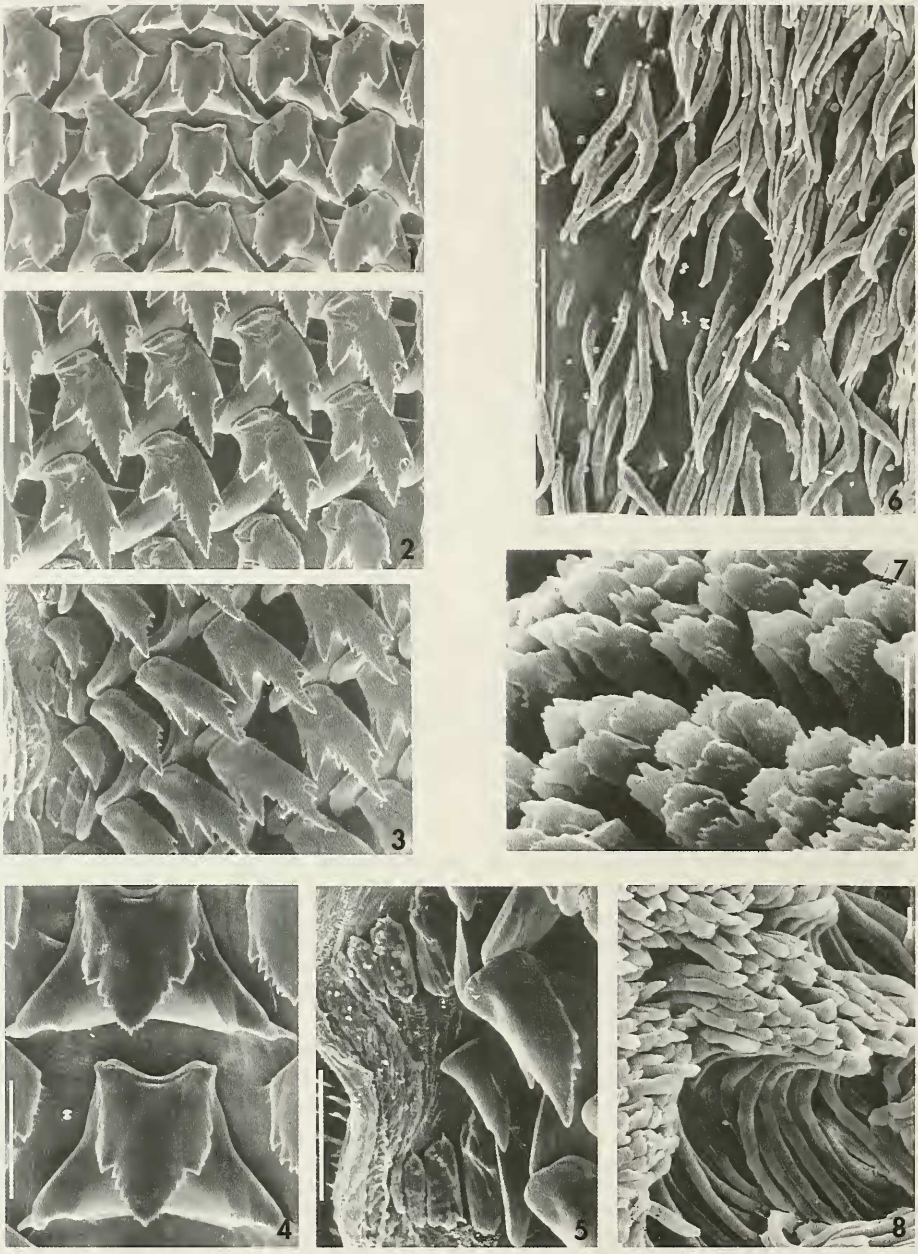
Aplysia gracilis Eales, 1960 was originally described from the Suez Canal as a new species, but some years latter the same author (EALES, 1979: 7) considered it as a juvenile stage of *A. fasciata*.

Material examined

- Spain: Cabo Peñas, Asturias (NW Spain), one specimen, 124 mm preserved lenght (Martínez coll., 1992); Eo estuary, Asturias, three specimens, more than 150 mm preserved lenght (Martínez coll., 1992).
- Italy: Fusaro lake, Naples gulf, one specimen, 80 mm preserved lenght (Martínez coll., 1993).
- Cape Verde: Matiota, San Vicente island, one specimen, 70 mm preserved lenght (Rolán coll., 1985); Tarrafal, Santiago Island, seven specimens more than 200 mm preserved lenght (Rolán coll., 1986).
- Mauritania: Nouackchot, ten specimens between 38-54 mm preserved lenght (MNHN, Gofas coll., 1986).
- Ghana: Miemia, one specimen, 90 mm preserved lenght (MNCN, 15.05/21416, Templado coll., 1993); Sekondi-Takoradi, one specimen, 40 mm preserved lenght; Pumpuni, one specimen, 37 mm preserved lenght (MNCN, 15.05/21414, Templado coll., 1993); Bushua, one specimen, 28 mm preserved lenght (MNCN, 15.05/21415, Templado coll., 1993). Two specimens without specified locality, 86 and 32 mm preserved lenght (NHM, 1958.1.9.1-2, Irvine leg.), both labelled as *Aplysia brasiliana*. Paratypes of *Aplysia winneba*: 4 specimens from Christiansbourg, near Accra, Ghana, between 50 and 60 mm preserved lenght (NHM 1957.6.18.4-7, R. Bassindale coll.). One of them dissected for anatomical study.
- Angola: Corimba and Cacuaco, Bengo province, six specimens between 70-103 mm preserved lenght (MNHN, Gofas coll., 1981).
- Saint Helena: one specimen, 105 mm preserved lenght (NHM, 1968.4.8.1, Mellis coll.), labelled as *Aplysia brasiliana*.

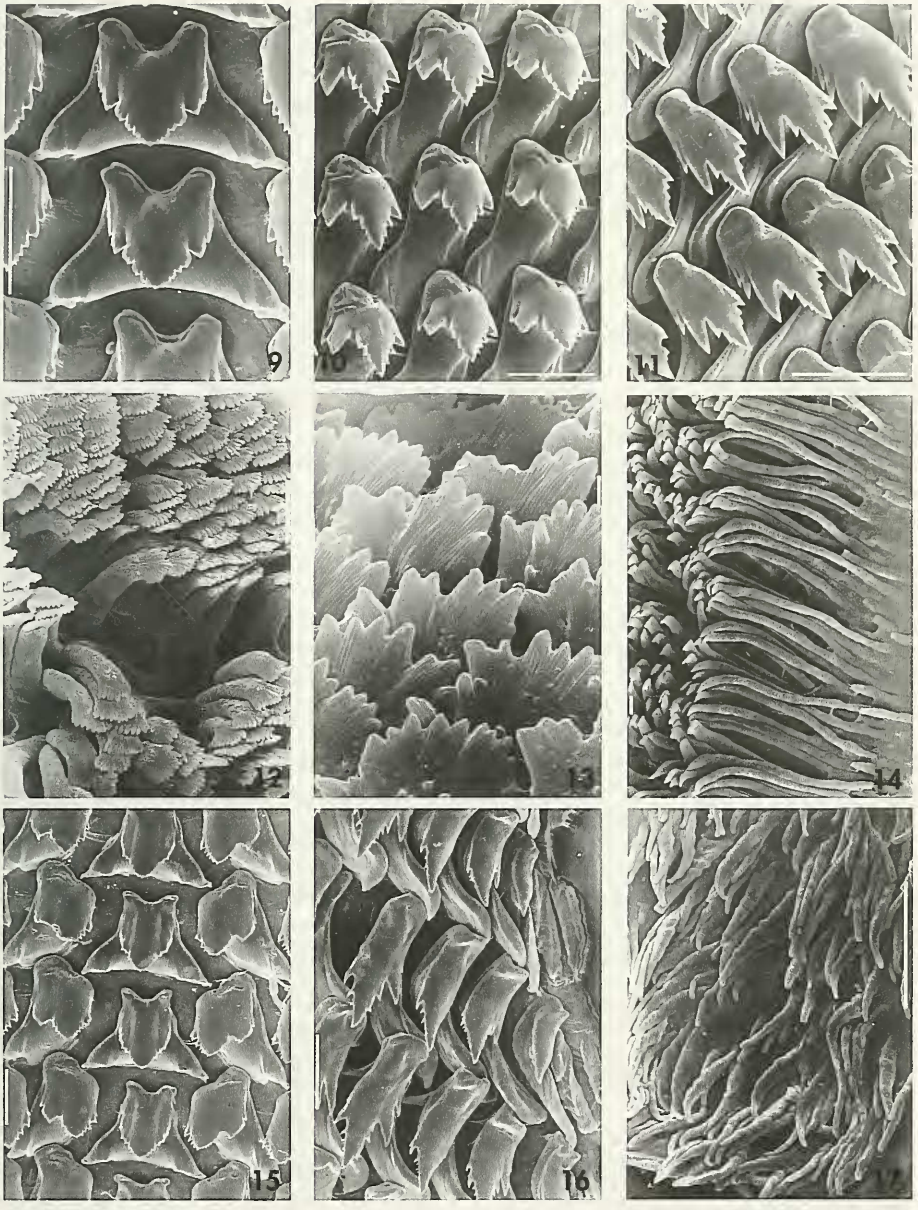
Original description of *Aplysia winneba*: EALES (1957a: 183) originally described *A. winneba* as follows: "Aplysias of moderate size, purplish black in colour, with vertical bands of dark and light on the inner sides of the parapodial edges. Highly mobile, with fimbriated cephalic tentacles, parapodia and anal siphon, moderately wide foot and short tail. Penis long and filiform. Mantle thin with a small tubular aperture. Purple glands present. Opaline gland compound, with a single conspicuous aperture".

Description of the *A. winneba* paratypes: According to the original description, the mantle has a small tubular aperture, whereas in the examined specimens of the paratypic series there is no such an aperture, but a minute papilla. In the dissected paratype, 60 mm long



Figures 1-8. Dissected paratype of *Aplysia winneba* (60 mm preserved lengh). 1: rachidian and first lateral teeth; 2: lateral teeth from sixth to ninth; 3: outermost lateral and marginal teeth; 4: detail of the rachidian tooth; 5: detail of the marginal teeth; 6: palatal teeth; 7: jaw elements; 8: jaw elements, near the masticatory edge. Scale bars, 1-6: 100 µm; 7, 8: 10 µm.

Figuras 1-8. Paratipo disecado de Aplysia winneba *(60 mm fijado). 1: diente raquídeo y primeros dientes laterales; 2: dientes laterales desde el 6º al 9º; 3: últimos dientes laterales y dientes marginales; 4: detalle del diente raquídeo; 5: detalle de los dientes marginales; 6: dientes palatales; 7: aspecto de los uncinos de la armadura labial; 8: los mismos, cerca del borde masticador. Escalas, 1-6: 100 µm; 7, 8: 10 µm.*



Figures 9-17. *Aplysia fasciata*. 9-14: Specimen from Ghana (40 mm preserved lenght). 9: detail of the rachidian tooth; 10: inner lateral teeth; 11: outer lateral teeth; 12: jaw elements; 13: a detail of jaw elements; 14: jaw elements, near the masticatory edge. 15-17: Specimen from Angola (70 mm preserved lenght). 15: rachidian and innermost lateral teeth; 16: last lateral and marginal teeth; 17: palatal teeth. Scale bars 9, 10, 11, 15-17: 100 µm; 12, 14: 10 µm; 13: 1 µm.

Figuras 9-17. Aplysia fasciata. *9-14: Ejemplar de Ghana (40 mm fijado). 9: detalle del diente raquídeo; 10: primeros dientes laterales; 11: últimos dientes laterales; 12: uncinos de la armadura labial; 13: detalle de los anteriores; 14: aspecto de los uncinos del borde masticador de la armadura labial. 15-17: Ejemplar de Angola (70 mm fijado). 15: diente raquídeo y primeros dientes laterales; 16: últimos dientes laterales y dientes marginales; 17: dientes palatales. Escalas 9, 10, 11, 15-17: 100 µm; 12, 14: 10 µm; 13: 1 µm.*

Table I. Comparative table of radular formulae of *Aplysia fasciata* specimens from different localities. (*) data from the dissected paratype of *Aplysia winneba* Eales; (**) data from the original description of *Aplysia winneba* Eales.
Tabla I. Tabla comparativa de las fórmulas radulares de ejemplares de Aplysia fasciata *procedentes de distintas localidades. (*) datos del paratipo disecado de* Aplysia winneba *Eales; (**) datos de la descripción original de* Aplysia winneba *Eales.*

Species	Locality	Formula	Animal lenght	Reference
A. fasciata	Angola	38 x 3.25.1.25.3	70 mm	this paper
A. fasciata	Angola	39 x 3.24.1.24.3	103 mm	this paper
A. fasciata	Ghana	37 x 4.18.1.18.4	40 mm	this paper
A. fasciata	Ghana	29 x 4.12.1.12.4	28 mm	this paper
A. winneba *	Ghana	39 x 4.24.1.24.4	60 mm	this paper
A. winneba **	Ghana	55 x 3.34.1.34.3	70 mm	Eales, 1957
A. fasciata	Mauritania	31 x 3.21.1.21.3	54 mm	this paper
A. fasciata	Cape Verde	49 x 4.23.1.23.4	70 mm	this paper
A. fasciata	Asturias (NW Spain)	50 x 3.33.1.33.3	125 mm	this paper

after fixation, the nervous system shows the cerebral ganglia completely fused together. The opaline gland is compound, resembling a bunch of grapes, well developed and with a single aperture.

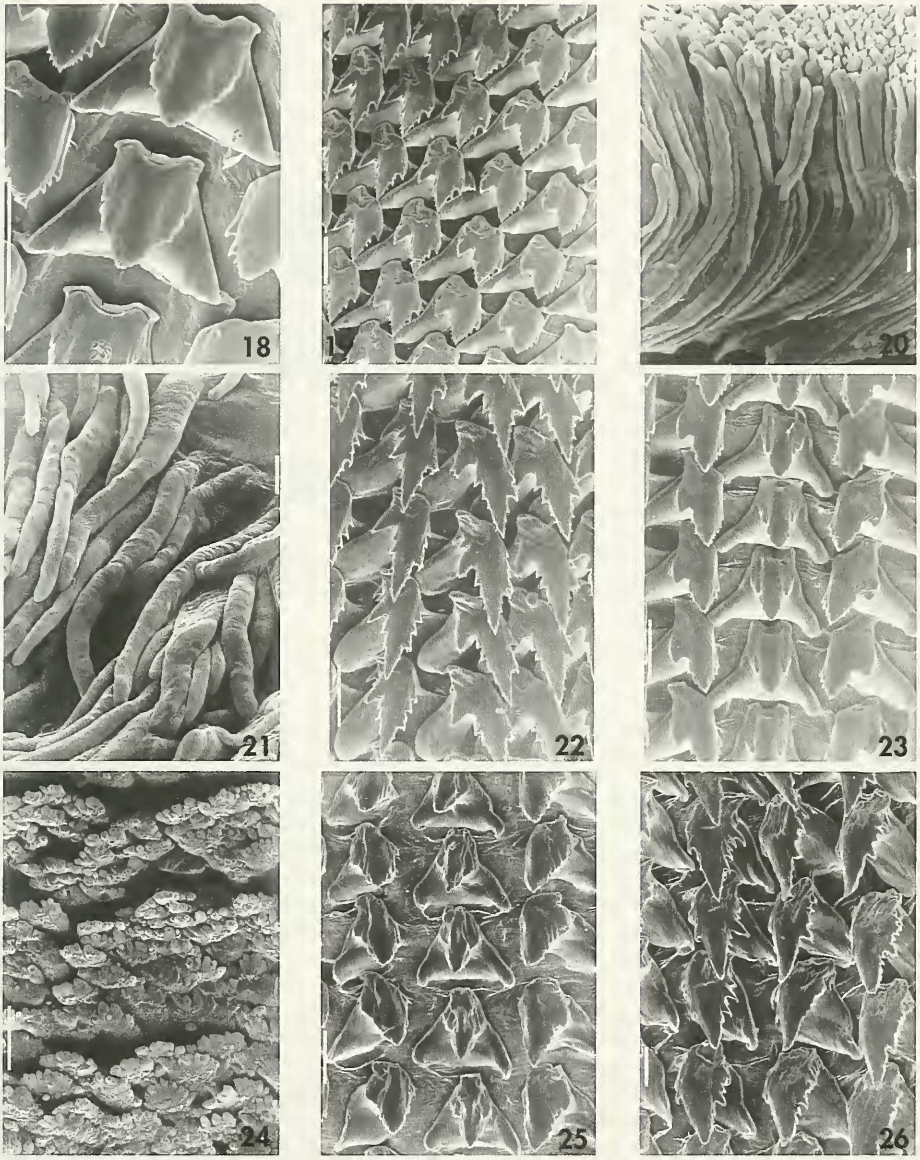
The radular formula is 39 x 4.24.1.24.4, and the SEM study shows a high rachidian tooth, with a denticulated central cusp and two secondary and smaller cusps on each side, the outermost less developed (Figs. 1, 4). The inner lateral teeth have a main denticulated cusp that becomes longer and narrower along the half-row (Figs. 1-3); near the base of this main cusp there are two outer secondary cusps (the first one well developed), and also an inner secondary cusp. The four outermost teeth are vestigial (Fig. 5).

The jaws are two simetrical plates provided with numerous elements, each one with 6-9 short conical extensions at their free edges (Fig. 7). Near the masticatory edge, the jaw elements are long and narrow, bent and eroded at the edges (Fig. 8). The palatal teeth are hook-shaped and laterally compressed, long and wide at the base, becoming narrower towards the free edge (Fig. 6).

In the genital tract there is a glandular area near the end of the distal hermaphroditic duct, in front of and behind the gametolitic gland stalk opening (Fig. 27). The penial sheath had two retractor muscles, and some others that anchor it to the body wall. The penis is filiform (Fig. 28). On the inner side of the penial sheath there is a small flap near the fundus.

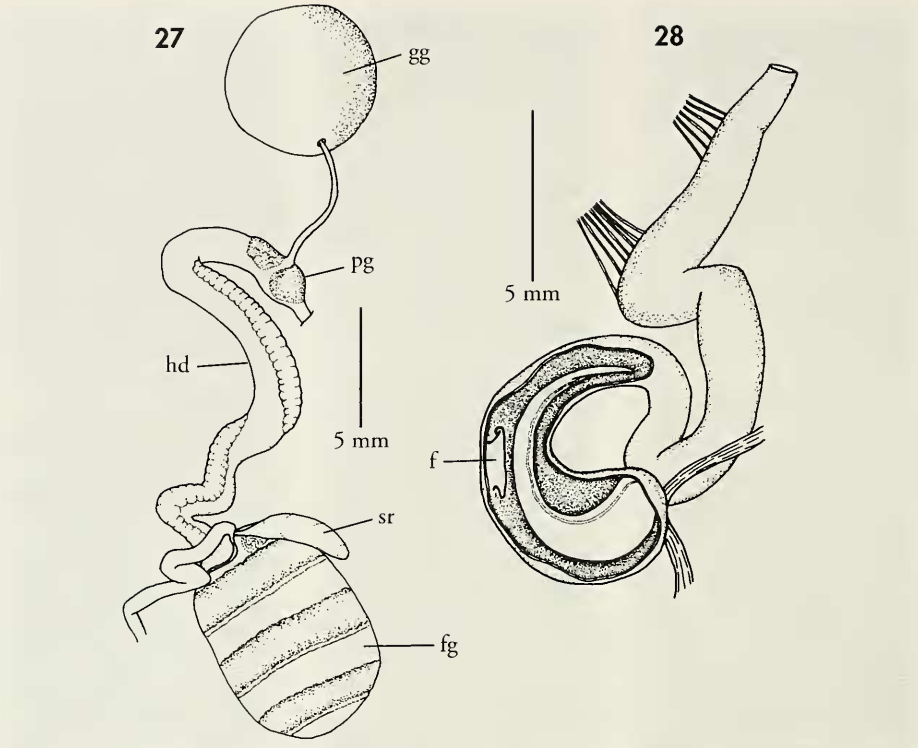
Description of the *Aplysia fasciata* material: Among all the examined material of *A. fasciata* only one specimen from Ghana has a small hole in the mantle, instead of a small papilla. The small preserved specimens from Ghana and Mauritania have the inner edge of the parapodial lobes with vertical bands of dark pigment, which are not visible in larger animals from other localities.

In all the dissected specimens, radular teeth show well developed and sharpened cusps. The rachidian tooth is wide at the base and it narrows towards the upper end. It has a central, denticulated cusp and two very small lateral cusps on each side (Figs. 9, 18). In larger specimens the rachidian tooth is higher and narrower, and the central cusp is longer (Figs. 15, 23, 25). Lateral teeth bearing a main, denticulated cusp that becomes longer along the half-row, having two (sometimes three) secondary cusps near the base, on the outer



Figures 18-26. *Aplysia fasciata.* 18-21: Specimen from Mauritania (45 mm preserved lenght). 18: detail of the rachidian tooth; 19: inner lateral teeth; 20: jaw elements, near the masticatory edge; 21: palatal teeth. 22, 23: Specimen from Naples (80 mm preserved lenght). 22: lateral teeth from 5th to 7th; 23: rachidian and innermost lateral teeth. 24-26: Specimen from NW Spain (more than 150 mm preserved lenght). 24: jaw elements. 25: rachidian and innermost lateral teeth; 26: lateral teeth, from 8th to 10th. Scale bars 18, 19, 22, 23, 25, 26: 100 µm; 20, 21, 24: 10 µm.

Figuras 18-26. Aplysia fasciata. *18-21: Ejemplar de Mauritania (45 mm fijado). 18: detalle del diente raquídeo; 19: primeros dientes laterales; 20: uncinos del borde masticador de la armadura labial; 21: dientes palatales. 22, 23: Ejemplar de Nápoles (80 mm fijado). 22: dientes laterales, del 5º al 7º; 23: diente raquídeo y primeros dientes laterales. 24-26: Ejemplar del noroeste de España (más de 150 mm fijado). 24: uncinos de la base de la armadura labial. 25: diente raquídeo y primeros dientes laterales; 26: dientes laterales, del 8º al 10º. Escalas 18, 19, 22, 23, 25, 26: 100 µm; 20, 21, 24: 10 µm.*

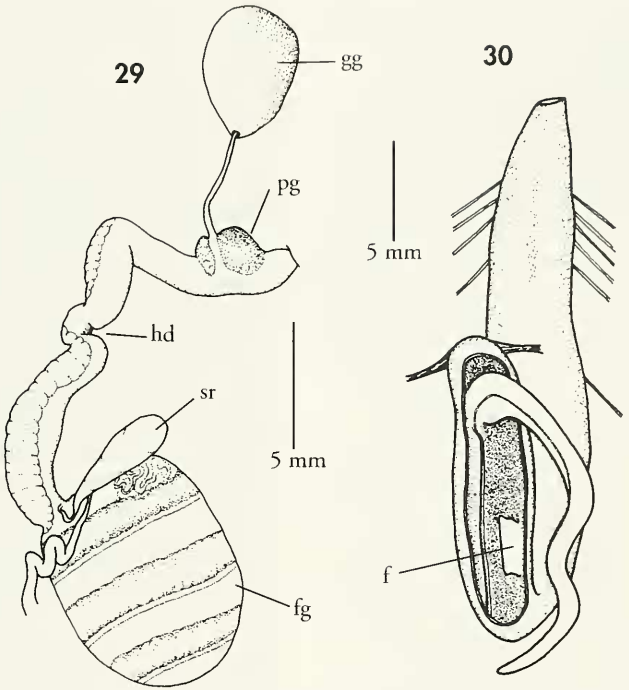


Figures 27, 28. Dissected paratype of *Aplysia winneba* (60 mm preserved lengh). 27: reproductive system; 28: opened penial sheath, showing the long and filiform penis, and the flap on the inner side of the penial sheath. Abbreviations. f: flap; fg: female glands; gg: gametolitic gland; hd: hermaphroditic duct; p: penis; pg: prostatic gland; sr: seminal receptacle.
Figuras 27, 28. Paratipo disecado de Aplysia winneba *(60 mm fijado). 27: aparato genital; 28: bolsa del pene abierta, mostrando el pene, largo y filiforme, y el pliegue del interior de la bolsa. Abreviaturas. f: pliegue; fg: glándulas femeninas; gg: glándula gametolítica; hd: conducto hermafrodita; p: pene; pg: glándula prostática; sr: receptáculo seminal.*

side, the first one well developed (Figs. 10, 11, 19, 22, 26). There is also a small secondary cusp on the inner side of the main cusp. About the four outermost teeth are vestigial (Fig. 16). Radular formulae for specimens from various localities are recorded in Table I; it shows that the number of teeth for each half-row is always less than 40.

Jaw elements are long and narrow (about 100 µm in a 40 mm preserved specimen) (Fig. 14). They have about 7-10 short conical extensions at their free edges (Figs. 12, 24) and, under high magnification, show longitudinal striae (Fig. 13). Towards the masticatory edge of the jaw plates these elements are eroded (Figs. 14, 20). Palatal teeth are long and hook-shaped (Figs. 17, 21), laterally compressed.

In the reproductive system there is a glandular area well visible as a widening of the distal hermaproditic duct, at the level of the gametolitic gland stalk opening (Fig. 29); The penis is long and filiform (Fig. 30). There is a small flap on the inner side of the penial sheath, that is always situated near the penial base, although its position can show some variation.



Figures 29, 30. Dissected specimen of *Aplysia fasciata* from Angola. 29: reproductive system; 30: opened penial sheath, showing the long and filiform penis, and the flap on the inner side of the penial sheath. Abbreviations as in Figures 27 and 28.
Figuras 29, 30. Ejemplar disecado de Aplysia fasciata *de Angola. 29: aparato genital; 30: bolsa del pene abierta, mostrando el pene, largo y filiforme y el pliegue del interior de la bolsa. Abreviaturas como en las Figuras 27 y 28.*

DISCUSSION

Aplysia fasciata is a well known species, whose most remarkable external features are the presence of two well developed parapodial lobes, widely separated anteriorly and posteriorly, and a mantle having a small hole or showing instead of this a minute papila; adults usually are dark in colour (velvety black), with red borders of the parapodia, cephalic tentacles and rhinophores (EALES, 1960; THOMPSON, 1976). Several anatomical studies have been published on this species. For instance RANG (1828: 55, pl. 6) described and figured very accurately the external morphology and the shell, and PILSBRY (1895: 72, pl. 33) figured the shell and the opaline gland (as *Tethys leporina*). EALES (1960: 316) described the radular morphology, and the reproductive system and the penial morphology have been described by THOMPSON AND BEBBINGTON (1969: 349).

As it has been previously commented, when EALES (1957a) described *Aplysia winneba*, she mentioned the structural resemblance between this species and *A. fasciata*; but in her opinion both differed "in shape, pigmentation, mode of contraction; in the width, toughness and frilled edges of the foot; in the size, height and fimbriation of the parapodia, and in the shell and radula". However, most of these characters (as the shape, pigmentation, size, width of the foot, etc.) are very variable with the state of preservation,

thus they have no taxonomic value when distinghishing between specimens of the two species.

EALES (1957a) provided a description of the colour based on some photographs of living animals as "purplish black in colour, with browner shades on the mantle". Although the typical coloration of *A. fasciata* is black with scarlet rims on the parapodia and tentacles, this pattern is normally present in the largest specimens, whereas smaller ones usually have a browner ground colour. The shell described by EALES (1957a) lacks a calcareous layer, but it is due to fixation.

Eales' description of the radula of *A. winneba* fits into the intraspecific variability of *A. fasciata*. Eales pointed out that both the rachidian tooth and the first lateral tooth have a rounded cusp; but in the examined paratype the cusps are more or less rounded only in the anterior half of the radula, because they are damaged by eating, which is very common within the genus *Aplysia*.

Comparison of SEM photographs of the radula and jaw elements of *A. fasciata* specimens from different localities and those of the paratype of *A. winneba* reveals an identical morphology in both groups of specimens.

According to THOMPSON AND BEBBINGTON (1969), the widening glandular area that may be discerned in gross dissections near the end of the distal hermaphroditic duct is the prostatic gland. In the penial sheath, the small flap is typical of *A. fasciata* and may act as a guide during mating, in THOMPSON' s opinion (1976).

Examination of several anatomical characters of the paratypes does not support the maintenance of *Aplysia winneba* Eales, 1957 as a different species and indicates that it is a synonym of *A. fasciata* Poiret, 1789. On the other hand a review of specimens from Ghana and Saint Helena that Eales identified as *Aplysia brasiliana* indicates that it was a missidentification, and that those specimens belong to the species *A. fasciata* (on the basis of their radular and penial morphology). In *Aplysia brasiliana* the penis is also long and filiform, but it widens considerably near the base and is flattened near the tip, and there is not a flap on the inner side of the penial sheath.

After this study, the known geographical range of *Aplysia fasciata* in the east Atlantic extends from the south west of England (GRIGG, 1949) and France (BEBBINGTON AND THOMPSON, 1968) to Angola and Saint Helena. New records in Mauritania and Saint Helena are given here. This species is also common in Mediterranean waters.

EALES (1979: 7) identified some specimens from Elat (Gulf of Aqaba, Red Sea) as *A. fasciata*, concluding that "this Mediterranean and eastern Atlantic species has extended its range southwards into the Indo-Pacific zone, and is the only member to the family to date to have done so". So, according to EALES (1979), *A. fasciata* is a lessepsian emigrant. Other species of *Aplysia* recorded at the Red Sea are *A. cornigera* Sowerby, 1869, *A. dactylomela* Rang, 1828, *A. oculifera* Adams and Reeve, 1850 and *A. parvula* Guilding in Mörch, 1863 (EALES, 1979; BARASH AND ZENZIPER, 1994), all them clearly different from *A. fasciata*. Nevertheless, the reference to *A. fasciata* in the Red Sea is doubtful, and the species was not included by BARASH AND ZENZIPER (1994) in their checklist of Opisthobranchs.

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